

WHAT IS CLAIMED IS:

- 1 1. A band-gap reference circuit, comprising:
2 a core reference circuit, having a core output terminal;
3 a voltage amplifier, coupled to the core output terminal and having a voltage
4 amplifier terminal;
5 a transconductance amplifier, coupled to the voltage amplifier terminal; and
6 a shared voltage rail, coupled to the core reference circuit and the
7 transconductance amplifier.
- 1 2. The reference circuit of claim 1, the core reference circuit comprising:
2 a first transistor, having a first collector coupled to the voltage rail, a first emitter
3 coupled to the ground, and a first base;
4 a second transistor, having a second collector coupled to the voltage rail, a
5 second emitter coupled to the ground, and a second base, coupled to the first base; and
6 a first resistor, coupled between the second collector and the voltage rail,
7 wherein
8 the core output terminal is coupled between the second collector and the
9 first resistor; and
10 said couplings are configured as one of a direct coupling and a coupling
11 across a resistor.
- 1 3. The reference circuit of claim 2, wherein at least one of the first transistor and
2 the second transistor comprises a plurality of transistors.
- 1 4. The reference circuit of claim 1, wherein:
2 the voltage amplifier comprises as input stage, comprising a third transistor, the
3 third transistor comprising:
4 a third emitter coupled to the ground; and
5 a third base, coupled to core output terminal.
- 1 5. The reference circuit of claim 4, wherein the reference circuit is operable to
2 generate a voltage-rail voltage essentially independent of the temperature.

- 1 6. The reference circuit of claim 1, wherein the voltage amplifier comprises more
2 than one stages.
- 1 7. The reference circuit of claim 1, wherein the transconductance amplifier
2 comprises:
3 a first stage, comprising a fourth transistor, the fourth transistor comprising a
4 fourth emitter, coupled to the ground, a fourth base, coupled to the voltage amplifier
5 terminal, and a fourth collector, coupled to the voltage rail, wherein the coupling of the
6 collector is one of a direct coupling and a coupling across a resistor.
- 1 8. The reference circuit of claim 1, wherein the transconductance amplifier
2 comprises more than one stages.
- 1 9. The reference circuit of claim 1, wherein the reference circuit is powered by a
2 voltage source and a current source, coupled in series with the voltage source, wherein
3 the serially coupled voltage source and current source are coupled between the ground
4 and the voltage rail.
- 1 10. The reference circuit of claim 1, comprising an output terminal coupled to the
2 voltage rail.
- 1 11. The reference circuit of claim 1, wherein the reference circuit comprises
2 transistors selected from the group on npn bipolar transistors, pnp bipolar transistors,
3 NMOS, PMOS, CMOS, and BiCMOS transistors.
- 1 12. The reference circuit of claim 1, wherein the voltage amplifier and the
2 transconductance amplifier comprise bipolar transistors as first stages, thereby keeping
3 the noise of the reference circuit below a predetermined level.
- 1 13. The reference circuit of claim 1, operable at a supply voltage in the range of
2 about 0.6 V to about 3V.

- 1 14. The reference circuit of claim 1, operable at a supply voltage in the range of
2 about 1.0 V to about 1.5V.
- 1 15. The reference circuit of claim 1, operable at a supply voltage above a band gap
2 voltage by an amount in the range of about 0V to about 0.5V.
- 1 16. The reference circuit of claim 1, operable with a ripple rejection ratio in the
2 range of about 50 dB to about 120 dB.
- 1 17. The reference circuit of claim 1, wherein a ripple rejection ratio is essentially
2 determined by a product of a transconductance of the transconductance amplifier and a
3 voltage gain of the voltage amplifier.
- 1 18. The reference circuit of claim 1, wherein the transconductance amplifier
2 introduces a negative feedback to the reference circuit and the voltage amplifier
3 introduces a positive feedback to the reference circuit, and the magnitude of the
4 negative feedback is bigger than the magnitude of the positive feedback.
- 1 19. The reference circuit of claim 1, wherein the reference circuit does not contain a
2 start-up circuit.
- 1 20. The reference circuit of claim 1, wherein the reference circuit does not contain
2 differential amplifiers.
- 1 21. The reference circuit of claim 1, wherein the spread of the reference circuit is
2 below a predetermined value, wherein the spread comprises the spread of the
3 parameters of similarly manufactured reference circuits.
- 1 22. The method of providing a band-gap voltage with a high ripple rejection ratio,
2 the method comprising:
3 providing a core reference circuit, having a core output terminal;

4 providing a voltage amplifier, coupled to the core output terminal and having a
5 voltage amplifier terminal;
6 providing a transconductance amplifier, coupled to the voltage amplifier
7 terminal;
8 providing a shared voltage rail, coupled to the core reference circuit and the
9 transconductance amplifier; and
10 selecting a transconductance of the transconductance amplifier and a voltage
11 gain of the voltage amplifier so that their product generates a band-gap voltage with a
12 ripple rejection ratio in the shared voltage rail above a predetermined value.

1 23. The method of claim 22, wherein the predetermined value is in the range of
2 about 50 dB to about 120dB.

1 24. The method of providing a band-gap voltage with a low supply voltage, the
2 method comprising:
3 providing a core reference circuit, having a core output terminal;
4 providing a voltage amplifier, coupled to the core output terminal and having a
5 voltage amplifier terminal;
6 providing a transconductance amplifier, coupled to the voltage amplifier
7 terminal;
8 providing a shared voltage rail, coupled to the core reference circuit and the
9 transconductance amplifier; and
10 selecting the parameters of the components of the core reference circuit, the
11 voltage amplifier and the transconductance amplifier so that the reference circuit and
12 the amplifiers can be operated at a supply voltage in the range of about 0.6V to about
13 3V.

1 25. The method of claim 24, wherein the minimum supply voltage is in the range of
2 about 1.0V to about 2V.